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Fall 2012

Quarterly Publication of the Engineers' Society of Western Pennsylvania

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Guest Editor Column

Thomas E. Donatelli, P.E.

Thomas E. Donatelli, P.E.

"To face tomorrow with the thought of using methods of yesterday is to envision life at a standstill."

This quote from James F. Bell is appropriate for this issue of the Pittsburgh Engineer which features Trends in Engineering and Construction.

During my almost 43-year career in engineering and construction, I have seen and experienced first-hand great advancements in our industry. Thinking back, I find it hard to believe that I started in this profession using a slide rule to perform calculations and a "Leroy" drafting pen set to produce design drawings. Can you imagine the man-hours needed to perform in this manner? We have advanced through the use of high-end calculators, computer programs, Computer Aided Drafting (CAD) and Building Information Modeling (BIM)— now we are working more effectively, quickly and efficiently then every before with the application of these technologies. Our article in this issue of Pittsburgh Engineer by Brian Skripac provides deeper insight to BIM, and we learn how this will advance our industry even further in the future.

While working in the public sector for Allegheny County, I was part of the emergency response team during many of the floods that occurred from 1985 to 2008. I recall the first flood I worked on in which my immediate supervisor proudly carried his new mobile telephone that weighed almost two pounds with very limited coverage—no laptops or Internet—and our response (as you could imagine) was indeed slow. In 2006 during Hurricane Ivan, things were much different. Our entire team used cell phones that captured every call and served as both phone and two-way radio. Communication was instantaneous with all emergency coordinators in the region. Laptops used Goggle EarthTM to review and record flood areas while various other programs rerouted buses around the flooded areas and emergency vehicles to the flooded areas. That storm event made me a believer in new technology and a proponent of familiarizing oneself with new advancements that increase efficiency. To continue James F. Bell's quote, "Each one of us, no matter what our task, must search for new and better methods—for even that which we now do well must be done better tomorrow".

Every action has a reaction. During the early 1900s, our region made a tremendous investment in infrastructure. Most of the regional bridges in use today were constructed from 1920 through 1960 when government's focus was on investing in our region. Approximately 64 cents of every tax dollar went into regional roads, buildings and bridges. Today, the investment is less than 8 cents of every tax dollar. It's difficult to comprehend how our forefathers built and financed the railroads, dams and interstates which we now find even more difficult to maintain. All federal, state and local governments are struggling with managing and maintaining the investment of their predecessors. We must look for new ways of funding infrastructure construction and maintenance, as stated in the article included here by Alan F. Wohlstetter on Public Private Partnerships (P3) as it relates to transportation in Pennsylvania. On July 5th of this year, Governor Tom Corbett signed Pennsylvania's Public Private Transportation Partnership Act into law. My research indicates that private coal companies owned and operated many Pittsburgh area bridges in the late 1800s and early 1900s, before the government acquired the 6th, 7th and 9th Street bridges. One could cross these bridges for a toll in the early 1900s before the Department of Army became involved. I had the opportunity to help develop a more recent partnership between PennDOT, Allegheny County, Robinson Park Associates (RPA) (private developer) and Bayer Corporation to construct the Settlers Cabin Interchange (I-376) under special legislation that advanced federal, state, local and private money through western Pennsylvania's first partnerships. The process took well over 20 years from the development of the agreement until the interchange was constructed. I'm confident the passage of this recent legislation will greatly enhance the process and open alternative ways of providing for investment in our vital infrastructure.

We include an article by Bernie Fedak, ESWP's 2012 Metcalf Award winner, on Current Trends in Engineering and Construction. His article reminds me of *World Class: Thriving*

Locally in the Global Economy (published in 1995) by Rosabeth Moss Kanter, which discussed how to turn globalization into an unprecedented opportunity on the local level. Bernie's article reinforces that globalization continues to be a significant trend in engineering and construction and the demand remains to perform safer, faster, better and cheaper on a worldwide scale.

With so much interest in GREEN technology and processes, this issue of Pittsburgh Engineer would not be complete unless we address it as it relates to transportation infrastructure. There has been much written about LEED Certification and green design on the building and facility side of our profession, but this is a completely new concept to the transportation industry. We have included an excerpted article that looks closer at sustainability in both the design and construction phases of transportation projects. The Federal Highway Administration (FHWA) is beginning to incorporate sustainable design requirements into future projects. Will this be a new and upcoming trend?

While our industry has historically striven to improve the life span and use of flexible pavement materials, advancements in the technologies needed to achieve those goals occur on a regular basis. Our final article focuses on such technologies related to asphalt material. During the late 1980s and early 1990s, "Cold-in-Place Asphalt Recycling" was introduced as a base application before a final overlay of a new wearing surface was installed on many Allegheny County road systems. This innovative process makes use of the original aggregate and some of the old asphalt cement that bound the aggregate into binders and wearing courses. Not only is this older aggregate often high quality, reusing it eases demand for quality virgin aggregate which is in limited supply in many areas. Unfortunately, this process did not gain favor and it is now difficult to find contractors who have the necessary equipment. Warm Mix Asphalt (WMA) has been on PennDOT's radar for over 10 years. Larry Bankert, Scott Nazar and Michael Bonini provide an article on the use of WMA and its benefits and future.

Trends shape our future and change is inevitable. Somewhat cliché, but those who set trends will definitely profit. Embrace change and profit from the experience.

I am extremely appreciative to everyone who contributed to this issue of the *Pittsburgh ENGINEER*. Thanks for your time and commitment. I would like also to thank the ESWP Publication Committee for their service and volunteerism to ESWP and its membership. PE

Thomas E. Donatelli, P.E. is currently the Assistant Vice-President of Construction for Michael Baker Jr. Inc. in Moon Township, PA. Previously, Tom served as the Director of Public Works for Allegheny County, PA for more than 20 years. Tom is the 2012-13 President of the Engineers' Society of Western PA.

BIM An Industry-wide Catalyst for Change

By: Brian P. Skripac, Assoc. AIA, LEED AP BD+C

"In every field of industry, new problems have presented themselves and new tools have been created capable of resolving them…If we set ourselves against the past, we can then appreciate the fact that new formulas have been found which only need exploitation to bring about (if we are wise enough to break with routine) a genuine liberation from the constraints we have till now been subjected to." ...- Le Corbusier, Towards a New Architecture.

While early visualization opportunities are an inherent by-product with BIM, it is much more than just a pretty picture providing a wealth of intelligent project information.

Architect Le Corbusier's 1931 manifesto explores the transforming capability of materials like concrete and steel in the construction industry, by surpassing the traditional limitations architects and engineers faced in realizing their designs.

While this was written in a much different era, the message holds true today. Architecture, along with the entire building industry, is in the middle of a dramatic transformation, linked directly to the paradigm shifts created by Building Information Modeling (BIM). Advances in technology can be seen as the "new tools," but it is their increasing adoption and continued exploitation by leading design professionals that acts as the catalyst for change, bringing about the liberation suggested by Le Corbusier.

The Problem

With these new tools becoming more accessible, emerging technologies allow us to overcome the fragmented linear workflow processes that our traditional project delivery methods have subjected us to. Often defined by the walls or silos of deliverables, traditional project delivery methods have information passing between team members at key project phases with minimal collaboration. This lack of integration is what promotes poor information flow, breeding a high level of redundancy, waste and deteriorating document quality as exhibited by the following Construction Management Association of America (CMAA) reports:

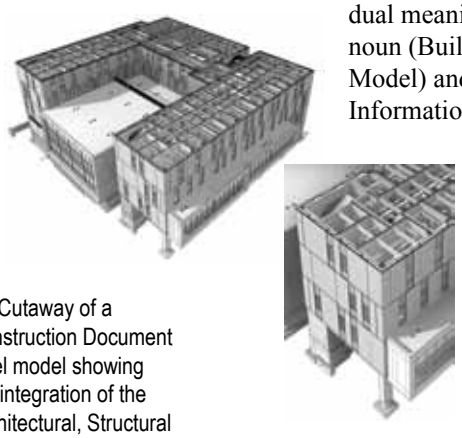
•92% of project owners said that architects' drawings are typically not sufficient for construction – CMAA Owners Survey, 2005.

•30% of projects do not make schedule or budget – CMAA Industry Report, 2007

Further quantifying this poor information flow, the National Institute of Standards and Technology's Cost Analysis of Inadequate Interoperability in the U.S. Capital Facilities Industry reported that "the construction industry in the United States wastes $15.8 billion annually due to inadequate interoperability among CAD, engineering, and other software systems." Further contributing to this waste are the industry's use of non-optimized technologies, where the focus is on individual project procedures and tasks, rather than on providing digital data that can support the entire building lifecycle.

BIM as the Solution

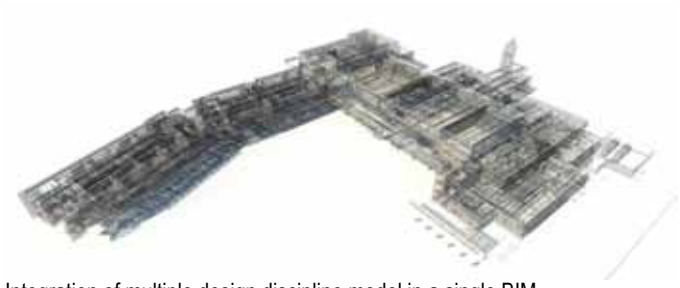
Initially addressing software issues, BIM has now developed into an enabling technology whose interoperable nature has opened the doors for new opportunities and processes beyond traditional means. At the same time, BIM is an acronym with multiple layers, taking on dual meaning as both a noun (Building Information Model) and a verb (Building Information Modeling).



3D Cutaway of a Construction Document level model showing the integration of the Architectural, Structural and MEP models to ultimately create the CD set of documents.

Our initial interpretation of a BIM (Building Information Model) has been crafted by today's technologies. Building Information Model authoring tools, such as Autodesk's Revit platform,

Bentley Architecture and ArchiCAD from Graphisoft to name a few, are transforming the way both architects and engineers design, by allowing primary design tools to transition from the traditional two-dimensional CAD platforms of the past. Using technology in the early stages of design, we can virtually construct the building long before ground is ever broken. While the BIM's three-dimensional nature is of tremendous value, its parametric nature is transforming the way we work, utilizing building components that are intelligent digital representations (objects). These objects "know what they are," and can be associated with both geometric and non-geometric information.



Integration of multiple design discipline model in a single BIM

Basis for Documentation

This resulting Building Information Model is available to serve as an accessible object in which the three dimensional characteristics of the project can visually support design decisions being made as early as possible. This same reusable model geometry also serves as a foundation for construction documents, where plans, sections, elevations, and schedules are derived directly from the model. With the information already present from the earlier design stages, project teams can now take advantage of it throughout the documentation phases, which in turn allows for a more streamlined process–yielding a consistent, better coordinated set of documents.

When building the model, a component as simple as a wall understands that it is comprised of much more than just two representational lines. Having a height, a thickness and a complex layering of its structure, substrates and finishes is relevant not only in a three dimensional view, but it also shows up appropriately in all other views, without having to be redrawn. If that wall were to be altered in any way (for example, changing its exterior finish material or thickness), that change would immediately be reflected throughout the project in all plans, sections, and elevations.

Not limited to only this geometric information, these building components are able to host a wealth of non-geometric information, taking on both the quantitative and qualitative aspects of the design. This information is what allows us to start looking beyond BIM as only the Building Information Model, and understand BIM as Building Information Modeling–a process. The process focuses on utilizing this digital prototype of the design to integrate all aspects of the design and construction, including the ones that were formerly disconnected.

Interoperability

While the BIM can hold a tremendous amount of meaningful data, it is not until we leverage its interoperability that we can fully realize its potential. These purpose-built conduits from one application to another create a dynamic exchange of information for platforms, serving the entire building community. Embracing this interoperability, the BIM is able to drive the production of a project's written documentation, as well as to perform complex analysis from the BIM without having to recreate the data. Once information in the model can be exchanged in this interoperable format, we can access many other technologies and integrate processes that were typically disconnected.

BIM – Integrating Architecture and Engineering.

Classifying the BIM's individual components (such as a wall or door) as assemblies enables a consistent language to be spoken. From here the design team can automate the production of their specifications while maintaining a synchronized link with the project drawings to the model from which they both originated. If an element exists in the model, it exists in the project manual, and this relationship can be maintained throughout the project as the design develops.

This same type of relationship (and consistent object classifications) creates a link between the model geometry, quantities and material costs. The immediate availability of area, volume, counts and other quantity takeoffs that remain accurate and up to date can provide direct feedback on the design's alignment with the project budget (better known as 5D construction), without the need for error-prone, time-consuming manual takeoffs to occur.

Having this iterative feedback from both the BIM and its related interoperable technology allows design teams to adopt a design-analyze-predict workflow, driving an efficient paradigm to support this early decision-making process.

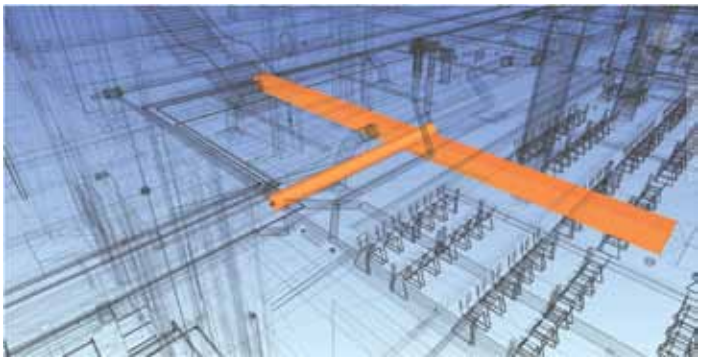
BIM for Engineers

Especially true in engineering firms, Building Information Modeling integrates design, engineering, analysis, and documentation from one consistent model. Structural engineers can build a physical model for design and documentation and leverage that geometry in creating the analytical model needed for calculating loads and sizing of their structural members. Available quantities such as room volumes can also be extracted as valuable design data. Reusable in heating and cooling load

calculations, the volumetric information is used by design engineers to validate equipment selection and sizing decisions. This is also the foundation of the sustainability of the Building Information Model, allowing it to address larger issues across the entire project and lifecycle of the building.

Analyzing and predicting these outcomes can have a significant impact on the occupant's satisfaction in the space, while helping to better understand the building's energy consumption and eventual operations cost from the earliest stages of the design. We can also look at other initiatives that control the greening of the design, by validating the impact that building orientation, window to wall ratios and daylighting will have on the project.

As a key collaboration tool, BIM's interoperable nature allows these different design discipline models to come together in a consolidated location. Acting as a digital light table, this integration of each discipline's model can automate the search for potential conflicts or interferences between the architectural envelope and engineering systems, better known as clash detection. Allowing for a higher level of discipline coordination to occur, Building Information Modeling presents the opportunity to identify and then resolve many uncertainties that typically arise in construction while still in the design phase–thus reducing their negative impact of the design intent, schedule and budget.



Clash Detection view highlighting a coordination issue between the plumbing and mechanical disciplines

Supply-Chain Integration

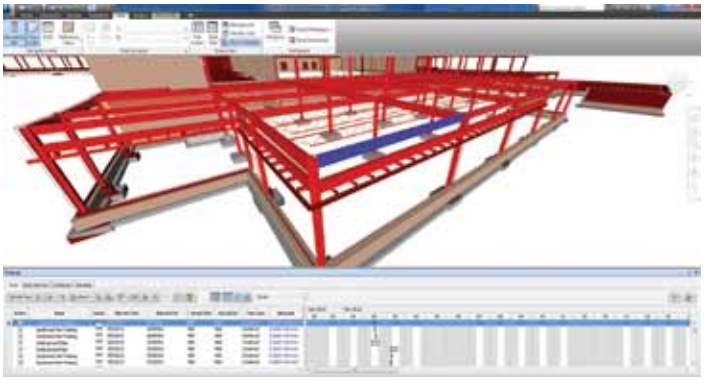
Looking to break down the industry's walls and silos, our project delivery methods need to react so that the BIM's value can extend beyond the traditional paper set of documents that are delivered. Acting as a digital prototype, the BIM can integrate into the shop drawing, fabrication and construction processes, similar to the way technology has allowed a supply-chain integration in the manufacturing, automotive and aerospace industries.

This design-construction integration focuses not only on designing the building, but also the process of constructing it. With the design intent more clearly defined in this three dimensional environment, a higher reliability of expected field conditions is available. From here, subcontractors can build upon this model in the pre-construction phase.

An example is the structural steel industry, where the BIM can be carried directly from design, to shop drawings, to a detailed model that can be used to fabricate the steel members. This fabrication model can then be integrated back into the consolidated model for coordination to occur at an install-ready level. Other disciplines such as mechanical and plumbing subcontractors are adopting this same type of workflow in the production of sheet metal for ductwork and components for plumbing assemblies. These advances in technology are creating opportunities for more materials to be prefabricated offsite, resulting in a higher quality outcome at a lower cost, while being able to expedite the construction schedule.

Assembling the Building in 4D

With this next level of digital information in place, the construction team can visually assemble the building over time by linking the model's geometry to the construction schedule. Known as 4D Phasing, this three dimensional schedule elaborates the ongoing constructability analysis by adding the aspect of time. Additionally, trade coordination and construction sequencing can provide valuable insight to maximize the work occurring on the jobsite. With the BIM actively maintained throughout construction, the building owner can expect a more accurate "as-built" set of documents or a BIM that can continue to be utilized into the operation and maintenance phases of the building's lifecycle.



4D modeling is where geometry is linked to construction sequencing schedules in Autodesk's Navisworks

Rather than sorting through rolls of drawings and boxes of maintenance warranty information, they can use the BIM as an integrated, accessible database for the owner and facility management team. Owners are able to track the people, spaces, and departments that comprise their facility, as well as being able to better understand the different planning, emergency and security relationships that come along with those elements. Additionally, the BIM can serve as a log to track the ongoing maintenance and servicing of the building systems enabling teams to work more in a proactive rather than a reactive operational model

Owner Benefits in Action

As the largest real estate owner in the country, the General Services Administration has seen the power of visualization, coordination, simulation, and optimization that Building Information Modeling technologies allow. Able to more effectively meet their design, construction, and program requirements, they have committed to a strategic and incremental adoption of these technologies by establishing their National 3D-4D-BIM Program. Additionally, other institutional building owners such as colleges/universities and healthcare facilities are seeing the value of BIM by defining their own BIM Guidelines

and deliverable requirements to optimize the value these new technologies bring.

Penn State University has been at the forefront of this evolution as seen in their BIM Planning Guide for Facility Owners which "presents a standard approach for facility owners to more effectively plan the integration of BIM throughout the organization and the lifecycle of a facility."

With technology allowing us to reuse and manage this vast amount of meaningful digital data in an interoperable format, throughout the course of our projects we can see the value of adopting these new tools. These new tools and expanding opportunities are a catalyst for change beyond our individual work, to include how we collaborate and deliver projects.

Integrated Project Delivery

Embracing the advances in technology, Integrated Project Delivery (IPD) has developed into a new way of working. By creating fully collaborative and highly integrated teams, IPD redefines the who, what, and how of the traditional design-bid-build project delivery process, more efficiently realizing the design. This redefined process leverages the vast amount of design information that is readily available by BIM, reinforcing the earliest possible decision-making. This maximizes our ability to affect change and minimizes the potential impact on the entire project.

Continuing the exploitation of these new tools and adopting the new formulas, such as American Institute of Architects Integrated Project Delivery Documents and the AGC of America's ConsensusDocs can truly bring about the liberation that was earlier suggested by Le Corbusier, but only if we are wise enough to break out of our routine. PE

About the author...

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INFRASTRUCTURE

ALERT

P3S FOR TRANSPORTATION IN PENNSYLVANIA: THE BRIDGE TO THE FUTURE

By Alan F. Wohlstetter

A Unique Opportunity

On July 5, 2012, Gov. Tom Corbett signed Pennsylvania's Public Private Transportation Partnership Act into law (the Pennsylvania P3 Act). The next day, President Obama signed the transportation funding two-year extension into law (MAP-21), providing $600 million in capital for both FY 2013 and FY 2014 for the TIFIA credit assistance program, up from $120 million in FY 2012. Taken together, these two transportation measures provide a mechanism for repairing, restoring and replacing Pennsylvania's structurally deficient bridges by harnessing private investors through a public-private partnership.

The Problem

Pennsylvania leads the nation in structurally deficient bridges: more than 4,800 as of March 2012[1]. And this is despite the expenditure of $570 million by PennDOT over the past four years to address this troubling problem. According to the Federal Highway Administration, 39 percent of bridges in the Commonwealth are structurally deficient or functionally obsolete. A proposal under the Pennsylvania P3 Act to address failing bridges in return for the right to toll such bridges — the Bridge to the Future Proposal — will capitalize on the simultaneous passage of the Pennsylvania P3 Act and MAP-21 to help accelerate project delivery, while avoiding a tax increase.

The Bridge to the Future Proposal

The Bridge to the Future Proposal would relieve the Commonwealth from the burden of restoring structurally deficient bridges by leasing identified bridges for up to a 99-year period in return for toll revenues collected at such bridges. The Pennsylvania P3 Act specifically authorizes revenue-sharing, so once the bridges are repaired and operating and maintenance costs provided for, there is no bar to the Commonwealth using additional revenue from the P3 to support untolled bridges[2].

A key element of the Bridge to the Future Proposal would be to combine it with a subordinated loan under the expanded TIFIA Program pursuant to MAP-21, which can fund the lesser of a third of the program or $50 million. The term of the TIFIA loan can be 35 years from the date the bridges are placed in service, and the loan can be interest only for five years after substantial completion. Since it is subordinated to any bank debt incurred by the P3, it facilitates the P3 obtaining an investment grade rating from at least one rating agency, a requirement under the TIFIA program. This helps ensure that the P3 is capitalized sufficiently to provide for the financial stability of the tolled bridges throughout the P3 concession period.

The Pennsylvania P3 Act

The requirements of the Pennsylvania P3 Act are important to understand in creating the Bridge to the Future proposal. First, a seven-member Public-Private Transportation Partnership Board (the Board) is created to consider all P3 proposals, consisting of the Pennsylvania Secretary of Transportation, the Secretary of the Budget, one member from each of the four Legislative Caucuses, and one member appointed by the Governor. If the proprietary public entity entering into the P3 with a private party would be the Commonwealth, the Legislature has the longer of 20 days or nine legislative days to disapprove any P3 approved by the Board.

Importantly, any P3 which is approved benefits from static tax treatment, with new taxes barred. Further, it is exempt from real estate transfer taxes, ad valorem property taxes and special assessments. The private entity will be granted the same electronic tolling enforcement powers as the Pennsylvania Turnpike Commission.

The Pennsylvania P3 Act has some limitations worth bearing in mind. First, any public employee in good standing who would lose his job as a result of the P3 must be offered a job with substantially identical salary, retirement and health care benefits. Any employee who declines such a position must be reassigned to an equivalent position at a nearby worksite without loss of seniority. P3 employees must be paid prevailing wage, and construction projects must comply with the Separations Act, requiring separate four-part bidding for the trades. Assets leased under a P3 must be returned at the end of the agreement in satisfactory condition at no further cost to the proprietary public entity. And a payment and performance bond will be required for construction projects. The P3 must also comply with the Steel Products Procurement Act, and there is a preference for P3s headquartered in Pennsylvania.

The Pennsylvania P3 Act requires that all funds derived thereunder be used for transportation purposes, ensuring that toll revenue will not be diverted to non-transportation needs. To guard against diversion, all funds the Commonwealth receives will be deposited in a Public-Private Partnership Account in the Motor License Fund, ensuring their use for transportation purposes. Under the Bridge to the Future Proposal, those funds could be used to repair bridges in rural communities where traffic would not support tolling. More than 40 percent of the bridges are structurally deficient in McKean, Potter, Clearfield, Lawrence and Schuylkill counties.

Federal Requirements

Federal Law similarly requires that toll revenue derived from such a P3 be used for transportation purposes:

> …all toll revenues received from operation of the toll facility will be used first for debt service, for reasonable return on investment of any private person financing the project, and for the costs necessary for the proper operation and maintenance of the toll facility, including reconstruction, resurfacing, restoration, and rehabilitation. If the State certifies annually that the tolled facility is being adequately maintained, the State may use any toll revenues in excess of amounts required under the preceding sentence for any purpose for which Federal funds may be obligated by a State under this title. 23 U.S. 129(a)(3).

Conclusion

The Bridge to the Future Proposal would use the simultaneous passage of the Pennsylvania P3 Act and MAP-21 to cost-effectively address the problem of Pennsylvania's aging bridges. A P3 could borrow up to $100 million on a subordinated basis under the TIFIA Program, with the ability to borrow an additional $200 million pursuant to a rated bond financing. With tolling of bridges permitted under Federal law, the toll revenues on highly-travelled bridges would not only provide for repair, operation and maintenance of the tolled bridges, debt service on the bonds and the TIFIA loan, but also revenues to repair structurally deficient bridges in more rural areas. Such a program would provide $300 million to further leverage PennDot's extraordinary efforts to remedy the challenge that a system of 50-year old bridges brings.

1. Federal law requires states to inspect all bridges 20 feet or longer at least every two years.

2. Such a proposal is similar to the P3 proposal of the Indiana Department of Transportation to reconstruct the John F. Kennedy Memorial Bridge over the Ohio River. PE

About the author...

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ESWP Member News

More than 80 firms are represented in the Corporate Member program of the Engineers' Society of Western Pennsylvania (ESWP). Memberships are available at 3 levels: Gold, Silver and Bronze. Gold members are entitled to 14 memberships that can be exchanged by employees; Silver, 9; and Bronze, 5 — annual dues are $2400, $1700, and $1000 respectively. In addition, ESWP Corporate Member Firms may add 2 additional individuals in our Under-35 age category at no additional cost. More information can be found at eswp.com. Please contact the ESWP Office (412-261-0710) for additional details.

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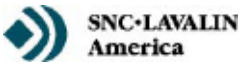

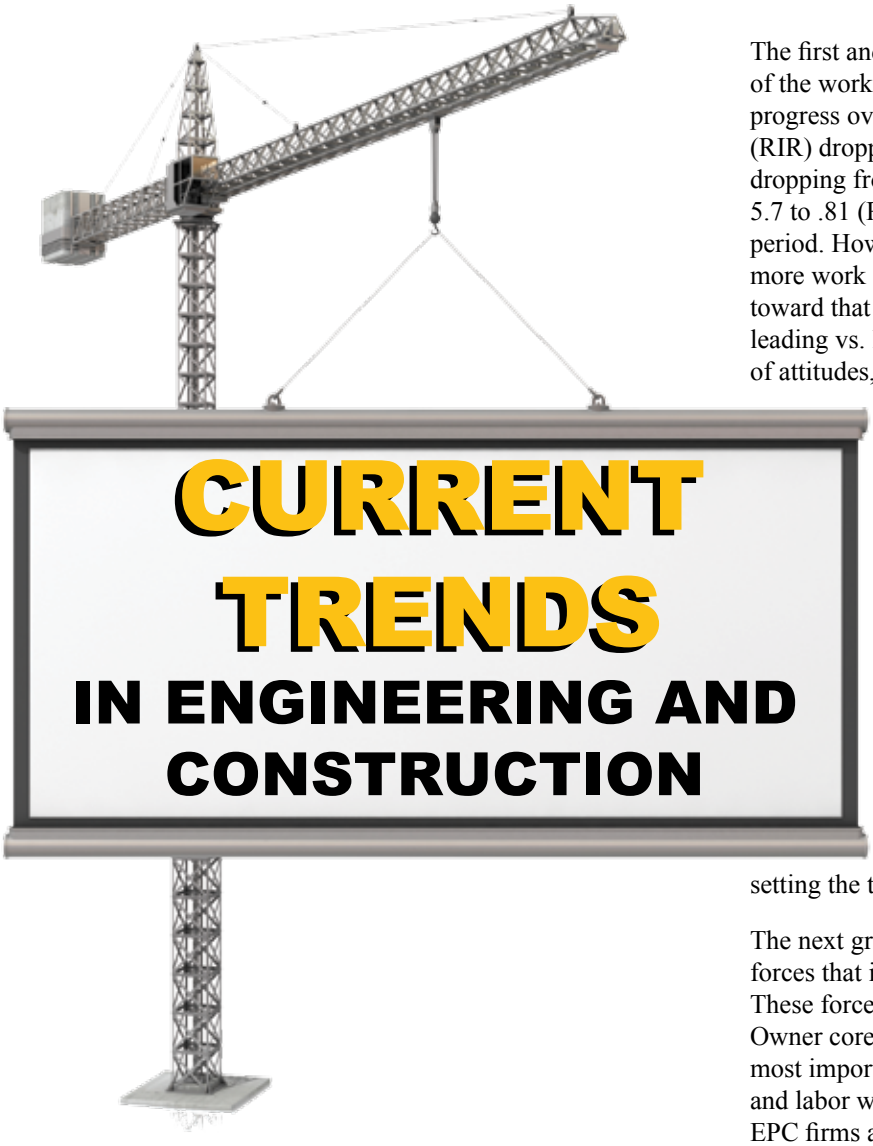

By Bernie Fedak

Construction today has become the necessary evil that represents the second to last activity in the quest to start up a new producing asset for an Owner with the last activity being commissioning. Construction scope has been reduced somewhat due to implementation of modular concepts, but to a large degree, it embodies the site-work, concrete placement, electrical, piping, steel and machinery installation required to create a new or to transform an old asset. The Construction Industry Institute ("CII") has thoroughly studied the capital execution process since 1983 with balanced input from Owner and Contractor members. Virtually all aspects of the process have been studied, and what I will discuss in this article comes largely from my association with CII and its collective body of knowledge and information.

Current trends in construction fall into 4 broad categories:

1. Safety
2. External impacts
3. Globalization, and
4. Execution practices.

Unfortunately space does not permit the depth of discussion that this topic deserves and requires, so I will just mention the most, in my opinion, significant trends affecting the industry.

The first and foremost focus in the construction industry is safety of the workforce. The industry overall has made significant progress over the past two decades with recordable incident rates (RIR) dropping from 13.7 to 4.0 and lost time rates (DART) dropping from 6.5to 2.1. CII members' rates have dropped from 5.7 to .81 (RIR) and 1.5 to 0.17 (DART) over the same time period. However, until zero accidents is a reality on all projects, more work still needs to be done. The most significant trend toward that end in the industry today is the emerging use of leading vs. lagging indicators. Leading indicators are measures of attitudes, behaviors, practices and conditions that influence construction safety performance. Leading indicators are divided into two categories, specifically passive and active. Passive leading indicators are safety strategies implemented before the construction phase begins and are not associated with any clear measurement; whereas, active leading indicators are measurements of safety performance made during the construction phase that can trigger the need for adjustments. The use of leading indicators will provide signals when specific corrective action needs to be taken to prevent an accident. More information on leading indicators can be found by accessing product number RT 284 on CII's website. One can look back on 29 years of CII zero accident safety research and see that the industry itself has been setting the trends toward achievement of this common goal.

The next grouping of trends is gleaned from the study of external forces that impact capital projects and the construction industry. These forces include aging, economic health, financing, risk, Owner core competencies and the environment. Perhaps, the most important of these issues is the aging of the management and labor workforces. In North America, Owner companies, EPC firms and the federal government all report a phenomenon of delayed retirements of its most senior workforce caused by devaluation of retirement plans. With hopefully a recovering economy and the normal aging of the workforce, a "retirement boom" is expected among the most experienced employees. CII members have indicated that project delivery performance deteriorates when projects are executed by lesser experienced employees. The trend here is obvious, and the industry must develop effective measures to counter the negative impacts of this loss of knowledge capital. These measures have thus far included structured mentoring between younger and more experienced employees and the development of structured knowledge management systems for documentation, sharing and institutionalization of the knowledge of those most experienced employees. In addition to aging, the industry faces a real challenge in attracting capable young people into its work force vs. the newer, more modern industry choices available.

Poor economic health in the United States has created government stimulus packages that have benefited the industry. This benefit will be short lived, however, and return to a stable, growing economy is required to sustain a healthy construction industry. Financing has become a bigger issue as Owners, EPC firms and general contractors step up their due diligence as part of their risk mitigation strategies. An attempt to push risk to the lowest element in the chain can sometimes result in unintended negative consequences.

Owner core competencies in the project arena have diminished greatly, thus, putting more performance pressure on contractors to perform and survive under very trying circumstances. The most important function of the Owner team is to provide a well-developed project and to control changes. The Owner team can also contribute positively to the safety, coordination, constructability, maintainability and operability of the project. Unfortunately, many Owners today do not consider capital project execution a necessary core competency. This is a trend that must be reversed.

The environment is playing an ever increasing role in projects and the construction industry. Increasing emphasis on emissions controls, sustainability, carbon footprints, etc. are driving the feasibility, size and the complexity of projects. Construction practices are also coming under scrutiny regarding emissions and sustainability. The good news may be more and higher value projects. The bad news is controlling the execution cost to stay competitive in the industry. The balancing act here, as long as the mandates are reasonable and achievable, will result in an improving environment for future generations.

Globalization continues to be a significant trend in the engineering and construction industry. Expansion by foreign firms into the U.S. market is creating more competition. I can speak from direct experience as my current employer, Kvaerner North American Construction Inc., is a subsidiary of a Norwegian company. There are presently over 100 international firms operating in the U.S. market with more coming. Globalization supports 24/7 engineering/production/ construction, which is of great benefit if managed properly. Out-sourcing of higher level services to low cost, best value countries continues resulting in engineering (and construction) companies in emerging markets with ever increasing capability. This creates new and more capable competition for U.S. based firms trying to compete in foreign markets. Intense competition coupled with increasing capability is also resulting in consolidations, mergers and acquisitions, which are creating national and international "megafirms." Some opinion exists that out-sourcing has gone too far, but that is currently the minority viewpoint.

The four largest markets for infrastructure are Brazil, China, USA and India. China may be softening a bit with the recent downturn of its economy, but the African market is looming on the horizon with engineering and construction pioneers establishing presences, new offices and strategic relationships with locally-connected firms. With frail consumer confidence and weak buying trends in the mature economies of Western Europe and North America, consumer product companies are looking to developing economies for business growth. This means that their major capital projects are there, not here.

Project execution trends have been many and varied in recent history as the demand and the effort to do it safer, faster, better and cheaper persists. Lean Construction, Integrated Project Delivery, Virtual Design & Construction – Building Information Modeling, Modularization and Automated Data Collection (RFID) are but a few of the continuing trends. Successful implementation of most project execution requires close cooperation among the project participants, including the Owner. THE most significant contributor to a successful project outcome is the quality of the up-front development effort by the Owner and the control of changes. Major trends to improve these two critical project areas would greatly benefit mankind from a project outcome standpoint. There are trends to improve these areas, but they cannot be considered major at this time.

The design and construction industry continues to work its way through a fluctuating economy. Hopefully at some point, construction activity will return to historical levels; otherwise, a "new normal" will have to be recognized and endured. Optimism exists for increased activity in both established and emerging markets. Collaboration of project teams, sustainable construction and application of modern technologies will be valuable tools for engineering and construction firms to perform safer, faster, better and cheaper. Efforts need to continue to educate Owners on the importance of project development, change control and most importantly the need for maintaining a core competency for project development within their companies. The trends identified here will surely shape the engineering and construction industry in the coming years. These trends will take twists and turns and more will be added as the one trend that overrides all of the others is the ever persistent trend of the world to change. PE

About the author...

Bernie Fedak has nearly 40 years' experience in the steel industry with Jones & Laughlin, LTV and U.S. Steel, where he held various engineering positions from Project manager thru Managing Director of Engineering. Bernie retired from U.S. Steel in 2005, and is currently Vice President of Operations with Kvaerner North American Construction. He served on the Board of the Engineers Society of Western Pennsylvania and was ESWP President in 1997 and 1998.

GreenLITES
GreenSCOR

There's a tried-and-true business saying: "If you can measure it, you can manage it." In practical terms, the process of measuring business performance occasionally reveals a wonderful surprise—you're doing many things right and achieving some very positive results in the process. The adage equally applies to managing transportation infrastructure projects. Measuring "sustainable" practices incorporates the strategic and purposeful use of resources in ways that do not exhaust those resources.

Photo provided courtesy of Michael Baker Corporation

These two new sustainability measurement standards focus on transportation infrastructure activities: GreenLITES, an adaptation of a design-phase measurement process initially developed by the New York State Department of Transportation (NYDOT); and GreenSCOR, a measurement process that applies to the construction phase of transportation infrastructure projects.

Practical Design and Construction Sustainability Metrics

Photo provided courtesy of Walsh Construction Company

"GreenLITES helps us take a closer look at sustainability in the design phase of transportation infrastructure projects," said Michael Baker Jr., Inc.'s (Baker) Mike Ryan, P.E., Vice President of Transportation, who is leading the development and implementation of these innovative approaches. "We did so to help us determine whether we were providing our clients with every potential sustainability solution possible, within reasonable cost.

"The process was intended to be client-interactive during the entire design process, so GreenLITES can't be a once-and-done effort, but ongoing," Ryan explained. "At the conclusion of the design phase, as the project goes to bid, it gets scored against the GreenLITES standards to see just how effective the sustainability features were.

Several GreenLITES program performance metrics include:

- Protecting and enhancing the environment (not disturbing trees, creating a green landscape, protecting endangered species, etc.)
- Conserving energy and natural resources: recycling, reusing asphalt and concrete, synchronizing traffic signals to reduce engine idling, using message boards powered by solar cells, and protecting natural animal crossings
- Preserving historic settings (using original architectural design features when building or restoring buildings)
- Engaging public involvement (using websites, newsletters, and ongoing outreach)
- Ensuring sustainable design (implementing new and innovative approaches while following the actual scorecard of current best sustainable practices in the industry)
- Smart growth and social planning land use (installing plantings on sidewalks and thinking strategically about landscaping decisions)
- Encouraging new ideas in sustainable design (awarding extra points for tactics not listed on the existing scorecard, then adding that tactic to subsequent scorecards)

New Jersey Department of Transportation's new Rt. 52 Causeway, connecting Ocean City and Somers Point, New Jersey, illustrates a major project incorporating strong sustainability practices. The Ocean City Causeway project included replacement of deteriorating trestle bridges, construction of two

new bridges, and building a new Visitors Center. Opportunities for sustainable design existed across all components of the project.

"We wanted to replace the existing Visitors Center within the city limits of Ocean City, but the real estate costs were too high, so we placed the new Visitors Center as part of the scenic overlook," explained Dave Lambert, who oversaw the Rt. 52 Causeway project for the NJDOT. "The old Visitors Center wasn't very big, so we were going to eliminate it. The City and the local Chamber of Commerce made persuasive arguments on the value of a visitor's center. Making it a part of the scenic overlook allowed us to apply a sustainable solution to everyone's satisfaction."

Extensive dialogue with numerous project stakeholders, including the public, revealed a strong desire for pedestrian access between Ocean City and Somers Point, since the old bridge was too dangerous for bicycle and foot traffic. As a result of the community involvement effort, a ten-foot multi-use sidewalk with crash-tested, AASHTO-approved barriers was included in the design to protect people from traffic. This feature conforms to NJDOT's 'Complete Streets' policy which has earned national recognition.

"The message to the communities was that this bridge must stand for 100 years—we'll have to live with this for a long time to come, so we want to do it right and do it with the communities' help," Lambert said. "Pier shapes, landscaping, sidewalks, lighting, all of these considerations were handled with respect to local opinions and efficiency in keeping the project moving ahead."

Baker's Mike Sidani, P.E., Rt. 52 Causeway project manage, noted, "Our objective in working with NJDOT, or in any sustainability effort, is to generate ideas that make sure we are providing clients with our best sustainable design practices. Applying GreenLITES allowed us to do just that."

Photo provided courtesy of Walsh Construction Company.

The Federal Highway Administration (FHWA) has considered defining national design sustainability standards by evaluating the GreenLITES program as utilized at NYDOT, among others. With the heightened awareness at the FHWA level, state DOTs and authorities are beginning to incorporate sustainable design requirements into future projects.

Photo provided courtesy of Walsh Construction Company.

With GreenLITES effectively addressing sustainability in the design phase and working so well in practice, the next logical step was to create a similar scorecard approach to sustainability practices in the construction phase by developing the "Green Sustainable Construction Operation Rating" (GreenSCOR) program.

GreenSCOR measures construction contractors' sustainable practices for fuel usage, locally-sourced supplies and materials, and more. Contractors have welcomed the GreenSCOR program and have received recognition for sustainable practices they've already implemented. GreenSCOR is one of the first complete construction scorecards in the industry.

"It was not good enough for sustainability to apply only to the project design phase—projects had to be constructed that way too," said Baker's Gary Chodkowski, P.E., who helped develop GreenSCOR. "The Pennsylvania Turnpike Commission (PTC) was the first client to approve scoring of construction projects using GreenSCOR—it's important to recognize PTC for its openness and willingness to see it through. And, since the

Photo provided courtesy of Walsh Construction Company.

Image provided courtesy of Michael Baker Corporation

beginning of 2011, GreenSCOR has been expanded to meet Pennsylvania Department of Transportation standards."

While neither a GreenLITES nor a GreenSCOR project, the I-90 Cleveland Innerbelt Bridge project in Cleveland, Ohio, provides another example of the two programs put to practical application.

The project specifications for Ohio Department of Transportation's (ODOT) $300 million project to replace the I-90 Westbound Bridge over the Cuyahoga Valley adjacent to Downtown Cleveland included a list of sustainability guidelines. Maximizing energy efficiency, the use of LED lighting, and minimizing fuel consumption characterized the guidelines.

By shortening the length of the main viaduct versus initial designs, and using roadway refill, ODOT reduced the need to excavate and remove earth by 50 percent. Then, by using trucks capable of carrying 40 cubic yards of earth, rather than the standard 10 cubic yard loads, resulted in fewer trips, less fuel consumption, and lower overall emissions.

"Our team proposed additional solutions that helped improve project sustainability," said Craig Hebebrand, ODOT project manager for the Cleveland Innerbelt Bridge project. "Air and water quality, stormwater management, community involvement initiatives, utilizing existing buildings for administrative and field offices, and reusing materials and recycling—all these sustainability practices were put into place.

"These proactive steps were not applied solely to be environmentally responsible, but they also made good economic sense—the two ideas are not mutually exclusive, but strongly complement each other." Hebebrand said.

"Sustainability in both design and construction is not just an idea," concluded Ryan. "It enhances the value of transportation projects at the local level. The typical "NIMBY" (not in my back yard) reaction is more commonly replaced with a more welcoming reaction. PE

Excerpted from Vol. IV, Issue III of Signature magazine, a Publication of Michael Baker Corporation.

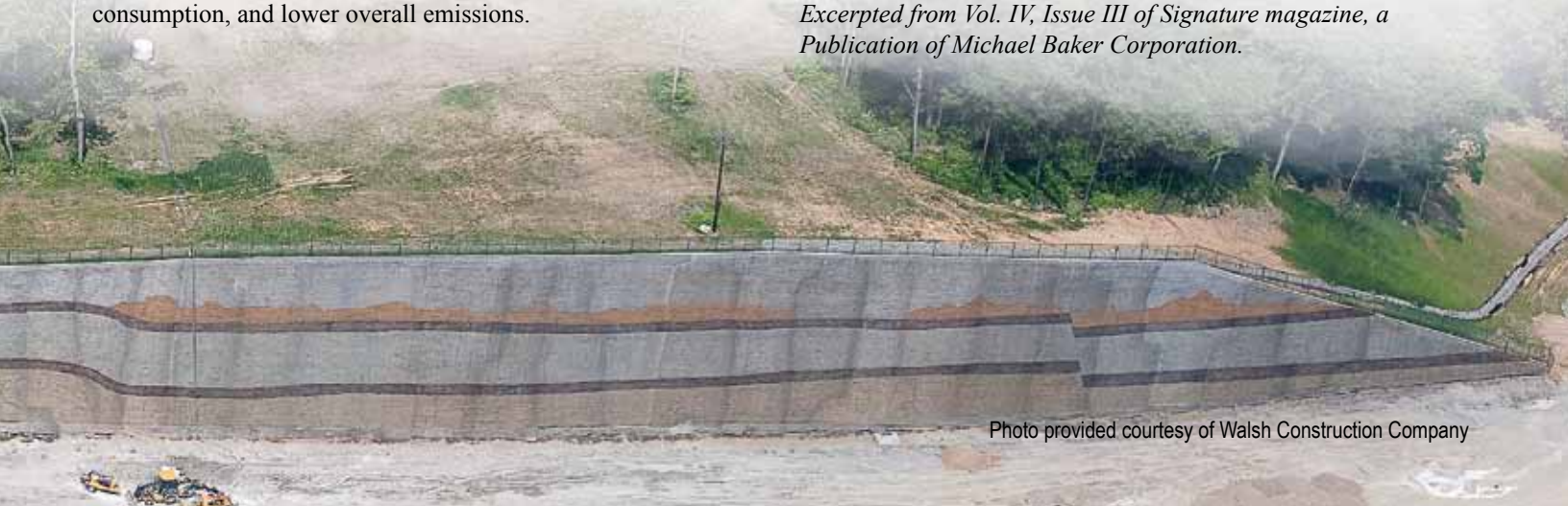

Photo provided courtesy of Walsh Construction Company

WARM MIX ASPHALT

By Larry Bankert, Scott Nazar, and Michael Bonini

WMA TECHNOLOGY

Warm Mix Asphalt (WMA) is plant mix asphalt produced and placed at lower temperatures than Hot Mix Asphalt (HMA) while maintaining the workability required to be successfully placed. When WMA is placed at ambient temperatures, typically above 50 degrees Fahrenheit, the asphalt mix temperatures are on average reduced by 25 to 80 degrees Fahrenheit (see Figure 1). The lower production temperature and placement of WMA benefits producers, workers, and the environment. Another benefit of WMA is the ability to apply it in lower ambient temperatures than HMA, thereby extending the paving season.

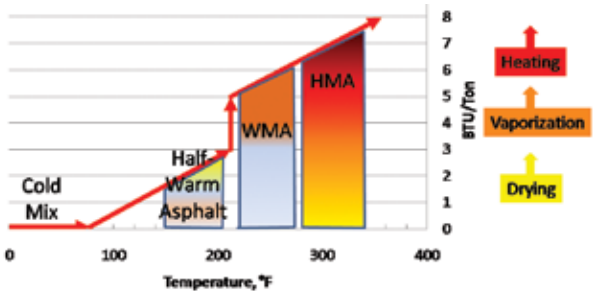

Figure 1. Mix temperature comparison.

WMA has been on PennDOT's radar for approximately 10 years. Beginning in 2002 with research in Europe and the United States, PennDOT kept a close watch on this alternative to HMA and followed national research studies and pilots. WMA has an additive that distinguishes it from HMA. The additive reduces the viscosity of the asphalt and enhances the workability by allowing for lower mixing and compaction temperatures.

There are over 30 technologies marketed and available in the United States, and there are currently 13 approved for use in Pennsylvania[1]. The technologies (additives and processes) are in three categories:

- Organic
- Chemical
- Foaming

The most commonly used additive or process is foaming.

BENEFITS

Because of the cooler production and application temperatures of WMA, there are significant environmental and safety advantages to WMA, including:

- Consumes less energy during production. With 47 million tons of WMA produced in 2010, the United States realized 30 million gallons of fuel savings worth more than $80 million when compared to HMA.
- Decreases in emissions during application. With the 2010 production levels, the United States also removed 800,000 tons of carbon dioxide-equivalent from the atmosphere. When warm mix is fully deployed, fuel savings will be equivalent to removing more than 1.5 million vehicles from the road every year.
- Reduces worker exposure to fumes during application. The exposure to smoke and dust is reduced by 30 to 90 percent as compared to HMA.
- Accommodates other green technologies. Early pilot projects suggest that WMA has the potential for high RAP (reclaimed asphalt pavement) ratios.

As an example of the reduced emissions, a plant in North Carolina experienced the following decreases with WMA production at 265°F:

- 17.6% decrease in SO2
- 3.2% decrease in CO2
- 35.3% decrease in total hydrocarbons
- 6.1% decrease in NOX

While WMA's benefits are primarily environmental, they are also operational and cost-effective:

- Extended paving season and nighttime opportunities. Relative to HMA, WMA cools more slowly and acts as a compaction aid. As a result, it can be placed successfully in lower ambient temperatures, thereby extending the paving season. It also makes night paving more feasible due to the cooler temperatures typically experienced.
- Ease of compaction and related cost savings. Additionally, WMA saves application time and costs. Because WMA makes compaction easier, cost savings are achieved by reducing time and labor spent compacting the mix.
- Increased hauling distances. WMA's lower temperature criteria permits greater hauling distances from plant to site.
- Decreased bid costs. When PennDOT maintenance forces use WMA or HMA, they purchase the materials through a Department of General Services (DGS) contract. In 2010 in Pennsylvania, bituminous materials were dual bid. And for a majority of line items, the WMA items were a lower cost than HMA, up to $5 per ton in some cases.

IMPLEMENTATION CONCERNS

If there are all these advantages, including cost-savings, why hasn't WMA been fully implemented? As successful demonstrations and pilots in Pennsylvania from 2009 and 2010 have turned into goals for increased use and implementation of WMA, some concerns were raised:

- Long-term durability,
- Moisture sensitivity,
- Unproven high RAP usage performance,
- Lack of a formal mix design,
- Lack of technology specific standard guidelines, and
- Lack of a formalized process to handle evaluation and approval of new technologies.

Over the last couple of years, research has been done at the state and federal level to begin addressing these concerns (see Figure 2). NCHRP Projects 09-43 and 09-47 address concerns relative to moisture sensitivity, mix design, and the performance of the technologies. In addition, the Pennsylvania State University has completed initial research related to the performance of high RAP usage in WMA.

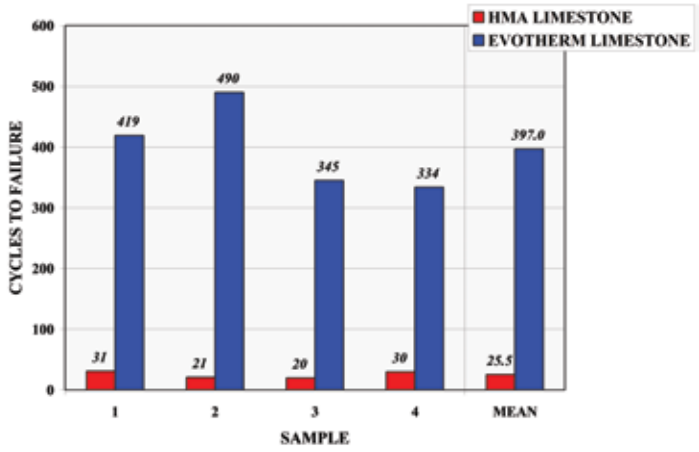

Figure 2. Texas Transportation Institute overlay test results HMA vs. WMA Evotherm Limestone

There are always concerns and a hesitation to implement change. "As with any new technology that challenges many years of a standard operating procedure, WMA encountered some push back" notes Scott Nazar, PennDOT Bureau of Maintenance and Operations Materials Innovation Management. While these concerns exist and are still being studied, most industry leaders agree that warm mix asphalt is the future of asphalt mixtures.

To illustrate this point, FHWA has included WMA as one of five technologies for accelerated deployment in its Every Day Counts program. The technologies included in this program are PROVEN technologies, including WMA. As FHWA states on its website, Every Day Counts is not about inventing the next 'big thing.' It's about taking effective, proven and market-ready technologies and getting them into widespread use. By advancing 21st century solutions, we can improve safety, reduce congestion and keep America moving and competitive. Many in the industry expect WMA to be one of those technologies.

THE PENNSYLVANIA EXPERIENCE

WMA is not foreign to Pennsylvania. In the last four to five years, Pennsylvania has progressed from considering pilot projects to using WMA for more than 20% of the tonnage of asphalt placed. Here is a timeline of WMA in PA:

- November 2007 – Letter to PennDOT District Offices was distributed soliciting WMA pilot projects
- April 2008 – First WMA pilot projects were let
- Construction Season 2008 – Three (3) pilot projects were constructed
- December 2008 – PennDOT expanded the use of WMA to non-federal aid projects
- June 2009 – WMA was expanded to federal aid projects with work plan
- Construction Season 2009 – Fifteen (15) WMA projects were constructed, including demonstration projects with evaluations
- June 2010 – PennDOT set an internal target of 20% WMA for 2010
- Construction Season 2010 – Twenty-three (23) projects were constructed and additional Department force paving projects performed.
- Construction Season FY 2011 2012 – PennDOT achieved 24% WMA use based on tonnage

THE FUTURE OF WMA IN PA

While the use of WMA is still in the minority, it is expected to continue to grow because of efforts to require WMA as AT LEAST an option to HMA for any PennDOT project bid in the future. PennDOT is considering a permissive bidding policy that would allow the application of any asphalt pavement to be either WMA or HMA, at the bidder's discretion.

September 2012 WMA paving project along SR 0008 in Crawford County, PA.

In addition, PennDOT expects to approve WMA specifications this month (October 2012). The specifications will be published in the April edition of PennDOT's Publication 408, Standard Specifications, making them readily available for next construction season.

The future of asphalt mixes in Pennsylvania seems to be going from hot to warm.

1. Reference PennDOT Publication 35 for a listing. ftp://ftp.dot.state.pa.us/public/pdf/bocm_mtd_lab/publications/pub_35/bulletin_15.pdf

About the authors...

Michael Bonini is the Research Manager for the Pennsylvania Department of Transportation (PennDOT). Michael serves as the Transportation Research Board (TRB) State Representative for PennDOT and is a member of several national transportation forums.

Scott T. Nazar is Section Chief, Materials Innovation Management for the Pennsylvania Department of Transportation (PennDOT) Bureau of Maintenance and Operations, Central Office, Harrisburg, PA. Scott has almost 20 years of related transportation experience.

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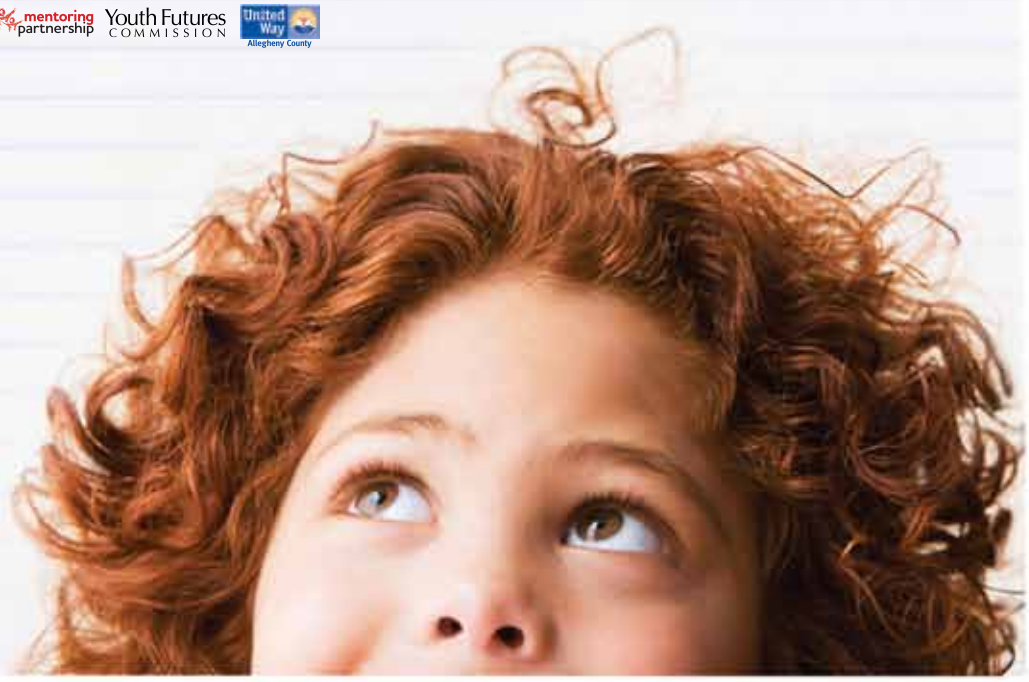


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